nodes looked for, because the distances between them remained unaffected on changing the rate of alternation. The distances from node to node also were found to measure different amounts (though on the whole there was a decided tendency towards regularity). The average distance apart of the nodes in the different rings tried lay between 10 and 18 inches.

The occurrence of the nodes might have been very well attributed to the ring being locally irregular in its susceptibility to induction, but for the irreconcilable fact that the effects on either side of a node were found to be of opposite phase, just as it would be, were the phenomenon due to stationary interference waves.

This was ascertained by means of two coils connected in the same sense in series with the telephone. When these coils were arranged at places of equal intensity, one on each side of a node, no sound was to be heard in the telephone, the effects neutralizing one another. A commutator, to throw in the coils singly or together as desired, is convenient for making this experiment.

From this, one would naturally assume that the currents induced on either side of a node must be of opposite sign, seeing that they neutralize each other in the telephone; but experiments with the galvanometer show it not to be the case. To test this, the galvanometer is connected up through a commutator arrangement fixed to the originator of the primary current in such a way as only to admit of the currents induced in one direction passing. Tried in this way, no difference in the direction of the current on either side of a telephone node was found, or, indeed, any trace of a minimum effect at these points. The thing can also be tested by means of a ballistic galvanometer, and a reversing key with battery, for, with a reversing key and telephone, the nodes, which are quite independent of the speed, are to be found, as well as the opposite phase effect. The ballistic galvanometer gives no indication of there being any difference at the nodes from elsewhere, and the deflection everywhere is in the same direction.

It was thought that perhaps the telephone effect was in some way connected with the fact that the form of the alternating current was not a simple wave or sign curve, owing to the method employed in producing it. This consisted of a rotating commutator, which threw in circuit alternately two cells connected up singly and in opposite directions. For this reason, the effect, when using a small alternating machine with about 40 alternations per second, was compared, and was found to be in no way different. Also what must have been a very regular variable current of the simple harmonic type was procured by means of a microphone and an organ-pipe. This gave like results.

One is thus left apparently to suppose the sound in the telephone to be due to a peculiarity in the character of the curve representing the rise and fall of the current, probably something of the nature of a subsidiary oscillation; this subsidiary oscillation being absent at the nodes, and of opposite sign on either side.

As mentioned before, it is necessary for the alternating coil to be placed at definite positions, in order that the system of nodes and internodes should occur. These positions of the alternating coil are at about the same average distance apart, and are of very much the same character with respect to regularity as the nodes of the telephone coil. In fact, if the alternating coil and the telephone coil change places round the ring, the best position for the alternating coil will always be between two nodes, and the nodes will be found situated between two old positions of the alternating coil. If the alternating coil be placed at a point where a node was found in some other position of the alternating coil, the system of nodes and internodes generally completely disappears, and now on moving the telephone coil round the ring the intensity uniformly diminishes until the diameter is reached, and then increases round the other half of the ring. This gives the phenomenon a distinctly resonant character. The induced current, as observed by a galvanometer, is always of the latter character—that is to say, a uniform fall, and then a rise on going round the ring.

As a rule the permanent magnetism of these large rings is irregular, and apparently apt to change frequently. A determination of the permanent magnetism was easily made by means of one of the coils connected with a ballistic galvanometer. By moving this through a given amount at a time, say an inch, and noting the throw of the needle, one was able to plot out a representation of the state of the permanent magnetism. In this way, places where no throw occurs were found, while to either side of such a point the throw changed sign. It was sometimes found that there was a decided tendency for the position of no throw to occur between two telephone nodes, the throw changing sign on either side of these points. But further experiments showed that this arrangement of the permanent magnetism was probably accidental, and due to the very currents employed in making the telephone observations. For when only very feeble currents had been used on a ring, these consequent poles were absent.

It is possible, as one would expect, to artificially make a minimum intensity position, at any point on a ring, by winding on a few turns of thick copper wire. But the fact that the phases on either side of such a point (found as before by means of two coils in circuit with a telephone) are the same, precludes the idea that the nodes can be due to Foucault currents.

Obviously, however, the phenomenon depends on some permanent peculiarity round the ring which happens to occur fairly regularly. What this peculiarity is, or how it is brought about, I have not yet been able to discover.

Fred. T. Trouton.

OYSTERS AT THE ANTIPODES.

So much attention has been given in England to the various questions connected with oyster-fisheries that it may be of interest to note some facts relating to the oyster-fisheries of our Australian kinsfolk. The subject was admirably dealt with in a lecture delivered by Mr. Saville-Kent before the Christchurch meeting of the Australasian Association for the Advancement of Science. This lecture is entitled "Oysters and Oyster-Culture in Australasia," and has been published separately.

Mr. Saville-Kent devotes attention chiefly to Australia and Tasmania, as, at the time when his lecture was prepared, he had not had an opportunity of personally studying the question in New Zealand. Beginning with Tasmania, where for five years he was officially connected with the oyster-fisheries, he points out that the oyster of Tasmania corresponds closely with the type *Ostrea edulis*, produced and cultivated in British waters. Formerly, this oyster was so abundant in Tasmanian waters, that, according to the report of a Royal Commission of Fisheries in 1882, about twenty years previously a quantity representing at current prices a retail value of no less than £90,000 had been exported in a single year to Victoria and New South Wales. At that time, oysters were so plentiful that it was a common practice to burn them in large quantities for the purpose of making lime. The strain was, of course, too severe, and by and by the Tasmanians found that, although there was still a demand for oysters, there was no longer a home-supply, and that it was necessary for them to go elsewhere for the commodity which they had so recklessly wasted. In 1884, when Mr. Saville-Kent reached the colony, the oyster-fisheries of Tasmania had for some years been an obsolete industry. Profiting by the information which had been made accessible through the International Fisheries Exhibition and associated Conferences in London in 1883, and by Prof. Hubrecht's testimony as to the oyster-fisheries of the Schelde, Mr. Saville-Kent recommended the establishment, in suitable localities, of efficiently-protected Government reserves, upon which breeding-stocks of oysters of the best quality should be carefully cultivated and permanently retained. These reserves were to fulfil the double purpose of breeding-centres, from whence the surrounding waters might be restocked, and also of model oyster-farms, around which private beds might be established on similar lines. The scheme recommended being approved, sites formerly associated with the most prolific oyster production were selected. The operations were necessarily conducted on a very modest scale. Oyster stock, suitable for laying on the reserves, could be accumulated only by slow and laborious processes, and some 20,000 to 50,000 oysters represented the approximate numbers that were gradually collected and placed under cultivation. In order that the largest possible amount of spat produced by the oyster stocks laid down might be caught, various methods were adopted, the principle being that which has been followed with so much success by M. Coste on the west coast of France. In addition to dead oyster-shells, or "cultch," which has, from the earliest days of oyster-culture, been recognized as representing a most natural and prolific catchment material for the adhesion of the spat, artificial collectors of various descriptions were introduced. In France, tiles cemented on their lower surfaces have been found to constitute the most productive and economic collectors. In Tasmania, as in all the other Australasian colonies, tiles being much too expensive for such a purpose, a cheap and efficient substitute for them was effectually improvised out of the thin roughly-cleft boards known as "split palings," which can be produced in timber-producing districts at a cost of from 8*s.* to 10*s.* per 1000. These paling collectors are coated on their under surface with cement, a brick or stone is fastened underneath at each end to give them stability, and a wire loop secured through the centre of their upper surface forms a convenient handle by which they can be manipulated on shore or raised with a boat-hook from beneath the water.

The results have been most satisfactory. Last year oysters had become so plentiful at Spring Bay that the Hobart market was glutted, and the sale price was reduced 50 per cent. Thus an important industry has been revived, and there can be little doubt that by the due maintenance of the breeding-reserves the oyster-fisheries of Tasmania will be restored to more than their former prosperity. In accordance with Mr. Saville-Kent's recommendations, all holders of private oyster-beds in Tasmania are bound by the terms of their leases to retain a certain amount of breeding-stock—not less than 10,000 mature oysters to the acre—permanently on their oyster-beds. This regulation contributes materially towards the distribution of spat throughout the surrounding water, and to the re-establishment of the oyster-fisheries upon a durable basis.

Referring next to Victoria, Mr. Saville-Kent says that the specific form of oyster indigenous to the Victorian coast-line is a so-called mud oyster, identical with that produced in Tasmanian waters, and to all outward appearance indistinguishable from the British native, *Ostrea edulis.* In former years vast quantities of this oyster were obtained from Western Port Bay, Port Albert, and Corner Inlet. Over-dredging, however, has reduced these prolific natural beds to the very verge of extinction, so that Victoria has for many years been dependent upon New South Wales, Queensland, South Australia, and New Zealand, for her oyster supplies. Some time ago Mr. Saville-Kent was invited by the Government of Victoria to make a tour of and report upon the fisheries of the colony, giving special attention to the practicability of reviving the oyster-fisheries. As a result of that tour of inspection, he strongly recommended the adoption, at Western Port and Port Albert more particularly, of the methods which had proved so effective in Tasmania. One such reserve with a very small stock of oysters was formed at Port Albert. Unfortunately, however, the Government omitted to make provision for periodical skilled supervision, and the reserve dwindled away. As Mr. Saville-Kent says, unless such reserves can be maintained in efficient working order, and the operations periodically required thereon be supervised by a practical ostreculturist, the money expended on their establishment is simply wasted.

At various parts of the Victorian coast-line, Mr. Saville-Kent observed considerable numbers of oyster-shells, evidently derived from deep water, that had recently been cast upon the shore by storms. He consequently predicted that more or less extensive beds would be found off the coast; and off-shore beds have in fact been since discovered. Mr. Saville-Kent points out that a most favourable opportunity is thus afforded for the restocking of the in-shore fisheries.

In New South Wales a separate species of oyster has to be taken into consideration. The commercial species of this colony is the rock oyster, *Ostrea glomerata.* At the same time a mud oyster, identical with or most closely allied to the Victorian and Tasmanian type, *Ostrea edulis,* occurs in some numbers upon the coast, but in consequence of the hitherto profuse abundance of the rock variety it has not been considered worthy of commercial attention. In form and general aspect the New South Wales rock oyster somewhat resembles the Portuguese oyster, *Ostrea angulata,* and also the American *Ostrea virgineana.* With these two species it further corresponds in its breeding habits, which are essentially distinct from those of the English, Victorian, and Tasmanian mud oyster, *Ostrea edulis.* In the case of the Australian rock oyster there is no nursing of the young brood, which is turned out to shift for itself, not only in a shell-less but even in an unfertilized condition. Like the spawn of many fishes, these ova are fertilized in the water. They can be readily fertilized artificially, and Mr. Saville-Kent has found that four days after fertilization the shells, which make their appearance on the second day, become so dense that the embryo oysters can no longer support themselves in the water, but sink to the bottom, where they assume their permanently fixed condition. Such is the fecundity of this oyster that the rocks and every available hiding-place in the bays, estuaries, and inlets of the districts it affects become literally plastered with the embryo brood; and until quite recently, artificial culture in the scientific sense has in New South Wales been usually regarded as an unprofitable and unnecessary superfluity. Lately, however, the oyster-fisheries of the colony have been seriously damaged by a disease which either destroys the oyster or makes it unfit for food. Mr. Saville-Kent attributes this disease to the pollution of rivers. If he is right in this view, in support of which he has much to say, the oyster-growers of New South Wales will, as he says, have to make the most of the water area left to them where the water is pure. They may also have to turn their attention to the cultivation of the New South Wales variety of the mud oyster.

In Queensland, as in New South Wales, the only oyster used in commerce is the rock variety, which may be said to attain its maximum development in both quantity and quality in the Moreton and Wide Bay districts. In these areas the species is so abundant that large consignments, above those required for home consumption, are exported to New South Wales and Victoria. The disease which has so seriously depleted the fisheries of New South Wales has not yet affected the Queensland beds. Mr. Saville-Kent thinks that this immunity is probably due to the circumstance that the Queensland oyster-fisheries are chiefly located in bays and channels in close proximity to the open sea, from whence, even after heavy floods from the tributary rivers, they are speedily revived by an inflow of sea-water. He urges the Queensland authorities to preserve these tributary streams as far as possible from pollution by chemical or other noxious works, which if allowed to increase to any considerable extent cannot fail to exert a very deleterious effect upon both the oyster and all other fisheries of the bays into which the rivers flow. Artificial oyster-culture, with the exception of one or two small experiments, has been so far carried out in Queensland waters on the simple lines only of transporting the young brood or ware, locally known as "cultivation," from one locality and laying it down on ground where it will develop more speedily to maturity. Mr. Saville-Kent believes, however, that it would be profitable to use split palings as spat collectors. One advantage possessed by this form of collector is the shelter from the sun's heat afforded to the young brood when left high and dry by the receding tide. Millions of the Australian rock oyster are destroyed annually through exposure to the overpowering heat of the subtropical sun in the early days of their attachment to exposed rocks near high-water mark. The overhanging ledges of larger rocks and the shady sides of stone jetties or embankments are invariably found to attract and support the greatest amount of oyster brood, and this shelter, which is naturally sought, plainly indicates the lines that may be most profitably followed in operations connected with the artificial cultivation of the species.

We may note that since Mr. Saville-Kent's lecture was published a report by him on "Oysters and Oyster-fisheries of Queensland" has been issued by the Queensland Government. In this report, which is carefully illustrated, full details are given as to the conditions which must be specially taken into account by all persons connected with Queensland oyster-fisheries. Referring to the "split paling" collectors, Mr. Saville-Kent emphatically repeats what he says in their favour in his lecture. After considerable experience he expresses his conviction that they are the most convenient and economic form for use in Australian waters, and that they may be characterized as an essentially Australian product. About half-tide mark represents the zone within which—at all times of the year, but especially in the months of February and August—they gather the most abundant harvest of spat. On their first attachment to the cemented collectors, the young oysters adhere to the cement by the entire surface of the attached shell. After attaining to about half an inch in diameter, the free edges of the shells begin to grow outwards, and this direction of their growth is continued until at an age of about six months they project an inch and a half or two inches from the collector. At this stage the young oysters may be easily detached with or without the cement, and be laid on the banks as ordinary "cultivation." The collectors may then be re-cemented and re-laid for the catchment of a second crop.

Of the oyster-fisheries of South and West Australia Mr. Saville-Kent is not able, in his lecture, to give precise details. He says, however, that excellent oysters of fine quality and magnificent proportions, allied to *Ostrea edulis*, are exported from Spencer's Gulf in South Australia to the Victorian markets, and more especially to Ballarat. Some of these South Australian oysters are of such Brobdingnagian dimensions that it is customary to cut them in four pieces for sale at the oyster saloons, the quarters thus divided being severally allotted to separate shells of ordinary size and sold as single oysters.

Mr. Saville-Kent congratulates New Zealand upon her abundant stores of oysters of various kinds. The days for the systematic artificial cultivation of the oyster in that colony have not yet arrived, and if she carefully husbands her natural resources they may, he thinks, be long delayed.

THE TIBET EXPEDITION.

AT an extraordinary meeting of the Russian Geographical Society on October 14, General Pevtsoff made his report about the Tibet Expedition, of which he was the commander after the death of Przewalsky. Having crossed the main Tian-shan ridge by the Bedel Pass, the Expedition went southwards, through an extremely narrow gorge of the Kara-teke ridge. In some places the gorge has only the width of 30 to 35 feet, while its walls are 700 feet high. The first Kashgarian village reached was Kalpyn, whence the travellers went to Yarkend. From Yarkend they moved on the great Khotan high-road into the northern spurs of the Kuen-lun. There they stayed for some forty days, at a height of 10,000 feet above the sea, at Tokhtahon, collecting many interesting plants and birds, while the geologist of the expedition, M. Bogdanovitch, made a long excursion into the region between the Yarkend-daria and the Tyznan Rivers. On September 13 they left the highlands, and after a three weeks' journey arrived at the Khotan oasis, the population of which (120,000) are skilful in the manufacture of carpets, felts, silks, and so on. From Khotan they went to Keria, and next to Niya, where they left their superfluous luggage, and whence they started to explore the Kuen-lun, in order to try to find a good pass to Tibet. The pass was found at the sources of the Tillan-hadji stream, not far from the Minjilin-khanum monastery. It proved to be quite available both for horses and camels. The winter was spent at Niya. On May 7, the work of exploration was resumed, and next week the Expedition reached the Kara-sai village. Followed by two men only, M. Roborovsky went up the Saryk-tuz Pass (discovered during the preceding autumn), and attained the sources of the Keriya-daria on the Tibet plateau. Its altitude proved to be there 16,500 feet, and its surface was an absolute desert. The want of food for the horses compelled M. Roborovsky soon to return to Kara-sai. He soon made a second attempt at further exploration, but, after having marched some 50 miles southwards on the plateau, he was again compelled to return. During the same time, M. Kozloff went across the border-ridge, following for some 100 miles the Bastan-tigrak River. He passed by Lake Dashi-kul and went up the river which flows into the lake from the east, through a wild desert, 14,000 feet above the sea. He also was soon compelled to return to Kara-sai. The next attempt was made by all three explorers together, accompanied by four Russians and a few natives. They went up the Aksu River, and soon were on a plateau, 15,000 feet high and almost quite devoid of vegetation. Terrible snow-storms were raging in the first days of July. The only mammals seen were two antelopes, and the only bird met with was a lark. Finding no food for the horses, the Expedition had nothing to do but to return to Kara-sai. Thence they started for Tchertchen, and at Atchan they were rejoined by M. Bogdanovitch, who had explored in the meantime the geological structure of the two passes of Saryk-tuz and Aksu. After a short stay at Mandalyk, where good grazing-grounds were found, and the horses recovered, the Expedition crossed again the Kuen-lun *viâ* the Muzluk Pass (15,500 feet high), and after having crossed it they divided into two parties, one of which, under M. Roborovsky, went south-east, and the other, under General Pevtsoff, moved southwards, up the little River Uluk-su, which is the source of the Tchertchen-daria. They soon came to an immense chalky mountain ridge, which rose to about 20,000 feet in the south, while a wide valley stretched south-westwards between that ridge and the Kuen-lun. The party stopped at the foot of this ridge, at a small lake, Yamil-kul. From some natives who were engaged in gold-mining in a gorge of the ridge, they learned that its name is Akka-tai, and that its summits are covered with perpetual snow. The party did not proceed further, and from Yamil-kul they returned to Mandalyk, and thence began their journey to Lob-nor, which journey took no less than one month. From Lob-nor the Expedition went up the Yarkend-daria, visiting on the way the great settlement of Kurla (4000 inhabitants), the fort of Karashar (10,800 inhabitants in the fort and the oasis), and the town Uruntchi, situated at the foot of the Tian-shan, and residence of the Governor-General of West China. On their way to the Russian frontier the travellers visited also the oasis of Sa-tsan, peopled by Chinese, and crossed the Malas River as well as the desert Khatyn-ula. On January 15, 1891, they entered the Russian post of Zaisan.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Rev. Andrew Clark, M.A., Fellow of Lincoln College, has been elected by Congregation a Curator of the Bodleian Library, in place of Prof. Max Müller, whose term of office had expired.

The Provost of Oriel College has been re-elected a Delegate of the University Museum.

Mr. F. Liddell, B.A. Christ Church, has been elected to a Fellowship at All Souls' College. Mr. Liddell, who is a son of the Dean of Christ Church, was placed in the first class by the examiners in the Final Classical Schools. Mr. A. H. Hardinge, M.A., formerly Fellow of All Souls' College, has been elected to a Fellowship under Statute 3, Clause 10, of the College Statutes.

There was no candidate for election to the Burdett-Coutts Scholarships. The scholarships are of the annual value of about £115, tenable for two years, for the promotion of the study of geology, and of natural science bearing on geology. This is the fifth occasion since the foundation of the scholarships that there has been either no candidate or no election.

In consequence of the requirements of the Civil Service Commissioners for the limited competition for assistantships in the Royal Observatory, Greenwich, the Savilian Professor of Astronomy has offered a short course of lectures on Newton's "Principia." The study of Newton has been practically abolished from the requirements of the Oxford Mathematical Schools for some time past.

A studentship, provided out of the funds of the Newton Testimonial Fund, having been offered to the University by the Managing Committee of the British School at Athens, the Craven Committee will proceed to make the appointment in the course of the present term. The studentship is of the value of £50, and is tenable for one year. The holder will be required to reside at Athens for not less than three months during the ensuing winter and spring. Candidates should apply to the Secretary of the Board of Faculties, Clarendon Buildings.

CAMBRIDGE.—The first award of the Isaac Newton Studentship in Astronomy and Physical Optics has been made to Ralph Allen Sampson, B.A., Fellow of St. John's College, Cambridge.

Prof. Thomson, F.R.S., has been elected Chairman of Examiners for Part II. of the Mathematical Tripos.

The vacancy of the office of Superintendent of the Museum of Zoology will take place on January 1, 1892. The stipend is £200. Applications are to be sent to Prof. Newton before November 19.

The State Medicine Syndicate report that this year there were 64 candidates for the Diploma in Public Health, of whom 45 were successful. They propose, on account of the large number of candidates, to hold a second examination in the first week of April 1892. The Syndicate have resolved to transfer to the University a sum of £150 from their accumulated funds.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xiv. No. 1 (Baltimore, Johns Hopkins Press).—This number, which contains an excellent likeness and autograph of Prof. Klein, opens with articles by Goursat, "Sur une problème relatif à la déformation des surfaces," and by Appell, "Sur une expression nouvelle des fonctions elliptiques par le quotient de deux séries."—Major MacMahon, F.R.S., contributes a fourth memoir on a new